Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead

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[This is a draft document being provided to state, tribal, and federal comanagers for technical review.]

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C. Coho salmon

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This section deals specifically with coho salmon. It is part of a larger report, the remaining sections of which can be accessed from the same website used to access this section (http://www.nwfsc.noaa.gov/). The main body of the report (Background and Introduction) contains background information and a description of the methods used in the risk analyses.

C. COHO

C.1 BACKGROUND AND HISTORY OF LISTINGS

Coho salmon (*Oncorhynchus kisutch*) is a widespread species of Pacific salmon, occurring in most major river basins around the Pacific Rim from Monterey Bay in California north to Point Hope, AK, through the Aleutians, and from Anadyr River south to Korea and northern Hokkaido, Japan (Laufle et al. 1986). From central British Columbia south, the vast majority of coho salmon adults are 3-year-olds, having spent approximately 18 months in fresh water and 18 months in salt water (Gilbert 1912, Pritchard 1940, Sandercock 1991). The primary exceptions to this pattern are "jacks," sexually mature males that return to freshwater to spawn after only 5-7 months in the ocean. However, in southeast and central Alaska, the majority of coho salmon adults are 4-year-olds, having spent an additional year in fresh water before going to sea (Godfrey et al. 1975, Crone and Bond 1976). The transition zone between predominantly 3-year-old and 4-year-old adults occurs somewhere between central British Columbia and southeast Alaska.

With the exception of spawning habitat, which consists of small streams with stable gravels, summer and winter freshwater habitats most preferred by coho salmon consist of quiet areas with low flow, such as backwater pools, beaver ponds, dam pools, and side channels (Reeves et al. 1989). Habitats used during winter generally have greater water depth than those used in summer, and also have greater amounts of large woody debris. West Coast coho smolts typically leave freshwater in the spring (April to June) and re-enter freshwater when sexually mature from September to November and spawn from November to December and occasionally into January (Sandercock 1991). Stocks from British Columbia, Washington, and the Columbia River often have very early (entering rivers in July or August) or late (spawning into March) runs in addition to "normally" timed runs.

Status reviews

The status of coho salmon for purposes of ESA listings has been reviewed many times, beginning in 1990. The first two reviews occurred in response to petitions to list coho salmon in the Lower Columbia River and Scott and Waddell creeks (central California) under the ESA. The conclusions of these reviews were that NMFS could not identify any populations that warranted protection under the ESA in the LCR (Johnson et al. 1991, *FR* 56(124):29553), and that Scott and Waddell creeks' populations were part of a larger, undescribed ESU (Bryant 1994, *FR* 59(80):21744).

A review of West Coast (Washington, Oregon, and California) coho salmon populations began in 1993 in response to several petitions to list numerous coho salmon populations and NMFS' own initiative to conduct a coastwide status review of the species. This coastwide review identified six coho salmon ESUs, of which the three southern most were proposed for listing, two were candidates for listing, and one was deemed "not warranted" for listing (Weitkamp et al. 1995, *FR* 60(142): 38011). In October 1996, the BRT updated the status

review for the Central California (CC) ESU, and concluded that it was at risk of extinction (NMFS 1996a). In October 1996, NMFS listed this ESU as threatened (*FR* 61(212): 56138).

In December 1996, the BRT updated the status review update for both proposed and candidate coho salmon ESUs (NMFS 1996b). However, because of the scale of the review, comanagers' requests for additional time to comment on the preliminary conclusions, and NMFS' legal obligations, the status review was finalized for proposed coho salmon ESUs in 1997 (NMFS 1997), but not for candidate ESUs. In May 1997, NMFS listed the Southern Oregon/Northern California coasts (SONCC) ESU as threatened, while it announced that listing of the Oregon Coast (OC) ESU was not warranted due to measures in the OCSRI plan (*FR* 62(87): 24588). This finding for OC coho salmon was overturned in August 1998, and the ESU listed as threatened (*FR* 63(153): 42587).

The process of updating the coho salmon status review was begun again in October 1998 for coho salmon in Washington and the lower Columbia River. However, this effort was terminated before the BRT could meet, due to competing activities with higher priorities.

In response to a petition by (Oregon Trout et al. 2000), the status of Lower Columbia River (LCR) coho salmon was revisited in 2000, with BRT meetings held in March and May 2001 (NMFS 2001a). The BRT concluded that splitting the LCR/Southwest Washington coast ESU to form separate LCR and Southwest Washington coast coho salmon ESUs was most consistent with available information and the LCR ESU was at risk of extinction. Like the 1996 status review update, these results were never finalized.

The coho salmon BRT[1] met in January 2003 to discuss new data received and to determine if the new information warranted any modification of the conclusions of the original BRTs. This report summarizes new information and the preliminary BRT conclusions on the following ESUs: Lower Columbia River, Oregon Coast, Southern Oregon/Northern California coasts, and Central California coast.

[1] The biological review team (BRT) for the updated status review for West Coast coho salmon included: Dr. Robert Iwamoto, Dr. Orlay Johnson, Dr. Pete Lawson, Gene Matthews, Dr. Paul McElhany, Dr. Thomas Wainwright, Dr. Robin Waples, Laurie Weitkamp, and Dr. John Williams, from NMFS Northwest Fisheries Science Center (NWFSC); Dr. Peter Adams, Dr. Eric Bjorkstedt, and Dr. Brian Spence from NMFS Southwest Fisheries Science Center (SWFSC); and Dr. Reginald Reisenbichler from the Northwest Biological Science Center, USGS Biological Resources Division, Seattle.

C.2.3 CENTRAL CALIFORNIA COHO

C.2.3.1 Previous BRT Conclusions

The Central California Coast (CCC) coho salmon Evolutionarily Significant Unit extends from Punta Gorda in Northern California south to and including the San Lorenzo River in Central California (Weitkamp et al. 1995). The status of coho salmon throughout their West Coast range, including the CCC ESU, was formally assessed in 1995 (Weitkamp et al. 1995). Two subsequent status review updates with information pertaining to the CCC ESU were published by NMFS in 1996 (Schiewe 1996a, b). Analyses from those reviews regarding extinction risk, risk factors, and hatchery influences is summarized in the following sections.

Status indicators and major risk factors

Data on abundance and population trends of coho salmon within the CCC ESU were limited. Historical time series of spawner abundance for individual river systems were unavailable. Brown et al. (1994) presented several historical point estimates of coho salmon spawner abundance (excluding ocean catch) for the entire state of California for 1940 and for various rivers and regions in the early 1960s and mid 1980s (Table C.2.3.1). Coho salmon were estimated to number between 200,000 and 500,000 statewide in the 1940s (E. Gerstung, CDFG, pers. comm., cited in Brown et al. 1994). Coho salmon spawning escapement was estimated to have declined to about 99,400 fish by the mid-1960s, with approximately 56,100 (56%) originating from streams within the CCC ESU (Table C.2.3.1). In the mid-1980s, spawning escapement was estimated to have dropped to approximately 30,480 in California and 18,050 (59%) within the CCC ESU. Employing the "20-fish rule" (see status review update for Southern OR-Northern CA Coast coho salmon for details), Brown et al. (1994) estimated wild and naturalized coho salmon populations at 6,160 (47% of the statewide total) for the CCC ESU during the late 1980s (Table C.2.3.1). All of these estimates are considered to be "best guesses" based on a combination of limited catch statistics, hatchery records, and personal observations of local biologists (Brown et al. 1994).

Further information regarding status was obtained from Brown et al.'s (1994) analysis of recent (1987-1991) occurrence of coho salmon in streams historically known to support populations. Of 133 historical coho salmon streams in the CCC ESU for which recent data were available, 62 (47%) were determined to still support coho runs while 71 (53%) apparently no longer support coho salmon (Table C.2.3.2). A subsequent analysis of surveys from 1995-1996 found a somewhat higher (57%) percentage of occupied streams (Schiewe 1996b, based on pers. comm. with P. Adams, NMFS Southwest Fisheries Science Center).

Nehlsen et al. (1991) provided no specific information on individual coho salmon populations in their 1991 status review, but concluded that salmon stocks in small coastal streams north of San Francisco were at moderate risk of extinction and those in coastal streams south of San Francisco Bay were at high risk of extinction. A subsequent status review by the Humboldt Chapter of the American Fisheries Society (Higgins et al. 1992) found four populations (Pudding Creek, Garcia River, Gualala River, and Russian River) as high risk of extinction and five (Ten Mile, Noyo, Big, Navarro, and Albion rivers) as stocks of concern.

Table C.2.3.1. Historical estimates of coho salmon spawner abundance for various rivers and regions within the Central California Coast Evolutionarily Significant Unit.

	Estimated Escapement		
	CDFG (1965)[a]	Wahle & Pearson (1987)[b]	Brown et al. (1994)[c]
River/Region	**1963**	**1984-1985**	**1987-1991**
Ten Mile River	6,000	2,000	160[d]
Noyo River	6,000	2,000	3,740
Big River	6,000	2,000	280
Navarro River	7,000	2,000	300
Garcia River	2,000	500	
Other Mendocino County	10,000	7,000[e]	470[f]
Gualala River	4,000	1,000	200
Russian River	5,000	1,000	255
Other Sonoma County	1,000		180
Marin County	5,000		435
San Mateo & Santa Cruz Counties	4,100	550	140
San Mateo County	1,000		
Santa Cruz County (excl. San	1,500	50	
San Lorenzo River	1,600	500	
ESU Total	**56,100**	**18,050**	**6,160**
Statewide Total	**99,400**	**30,480**	**13,240**

[a]Values excludes ocean catch.
[b]Estimates are for wild or naturalized fish; hatchery returns excluded.
[c]Estimates are for wild or naturalized fish; hatchery returns excluded. For streams without recent spawner estimates (or estimates lower than 20 fish), assumes 20 spawners.
[d]Indicates high probability that natural production is by wild fish rather than naturalized hatchery stocks.
[e]Value may include Marin and Sonoma County fish.
[f.]Appears to include Garcia River fish.

Risk factors identified by the BRT included extremely low contemporary abundance compared to historical abundance, widespread local extinctions, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity. Additionally, the BRT concluded that the main stocks of coho salmon in the CCC ESU have been heavily influenced by hatcheries and that there were relatively few native coho salmon left in the ESU (Weitkamp et al. 1995). Most existing stocks have a history of hatchery planting, with many out-of-ESU stock transfers. A subsequent status review (Schiewe 1996a), which focused on existing hatcheries, concluded that, despite the historical introduction of non-native fish, the Scott Creek (=Kingfisher Flat) and Noyo River brood stocks have regularly incorporated wild broodstock and, thus, were unlikely to differ from naturally spawning fish within the ESU. Recent droughts and unfavorable ocean conditions were identified as natural factors contributing to reduced run size.

Table C.2.3.2. Historical presence of coho salmon in the CCC ESU, as determined by Brown and Moyle (1991) and the California Department of Fish and Game's analysis of recent presence (1995-2001). County classifications are based on the location of the mouth of the river system. Data from CDFG (2002).

	Brown et al. (1994) Calendar years 1987-1990				CDFG (2002) Years 1995-2001				
County/River Basin	**no. of streams**	**no. of streams w/info.**	**coho present**	**%**	**no. of streams surveyed in 2001**	**no. of streams w/coho present**	**no. of streams w/coho assumed present**	**no. of streams w/coho not detected in 2001**	**Percent present (1995-2001)**
Mendocino									
Coastal	44	35	13	37%	30	11	10	19	52%
Ten Mile River	11	10	7	79%	11	9	0	2	82%
Noyo River	13	12	11	92%	8	7	5	1	92%
Big River	16	13	11	85%	8	3	6	5	64%
Navarro River	19	8	4	50%	14	6	1	8	47%
Subtotal	103	78	46	59%	71	36	22	35	62%
Sonoma County									
Coastal	10	2	1	50%	4	0	0	4	0%
Gualala River	11	2	1	50%	10	0	0	10	0%
Russian River	32	24	2	8%	29	1	1	28	0%
Subtotal	53	28	4	14%	43	1	1	42	4%
Marin County									
Coastal	10	7	7	100%	15	6	0	9	40%
Subtotal	10	7	7	100%	15	6	0	9	40%
Tribs. to S.F. Bay									
Coastal	7	7	0	0%	6	0	0	6	0%
Subtotal	7	7	0	0%	6	0	0	6	0%
South of S.F. Bay									
Coastal	13	13	5	38%					
Subtotal	13	13	5	38%					
ESU Total	**186**	**133**	**62**	**47%**	**135**	**43**	**23**	**92**	**42%**

Previous BRT conclusions

Based on the data presented above, the BRT concluded that all coho salmon stocks in the CCC ESU were depressed relative to historical abundance and that most extant populations have been heavily influenced by hatchery operations. They unanimously concluded that natural populations of coho salmon in this ESU were in danger of extinction (Weitkamp et al. 1995). After considering new information on coho salmon presence within the ESU, the majority of the BRT concluded that the ESU was in danger of extinction, while a minority concluded the ESU was not presently in danger of extinction but was likely to become so in the foreseeable future (Schiewe 1996b).

Listing status

Coho salmon in the CCC ESU were listed as threatened in October 1996.

C.2.3.2 New Data and Analyses

Significant new information on recent abundance and distribution of coho salmon within CCC ESU has become available, much of which has been summarized in two recent status reviews (NMFS 2001; CDFG 2002). Most of these data are of two types: 1) compilations of presence-absence information for coho salmon throughout the CCC during the period 1987 to the present, and 2) new data on densities of juvenile coho salmon collected at a number of index reaches surveyed by private timber companies, CDFG, and other researchers. Excepting adult counts made at the Noyo Egg Collecting Station, which are both incomplete counts and strongly influenced by hatchery returns, there are no current time series of adult abundance within this ESU that span 8 or more years. Outmigrating smolts have been trapped at two trapping facilities in Caspar Creek and Little River since the mid-1980s; however, these are partial counts and only recently have mark-recapture studies been performed that allow correction for capture efficiency at these two sites. Thus, these smolt counts can only be considered indices of abundance.

Two analyses of presence-absence data have recently been published. CDFG (2002) performed an analysis that focused on recent (1995-2001) presence of coho salmon in streams identified as historical producers of coho salmon by Brown and Moyle (1991). NMFS (2001) published an updated status review that analyzed coho salmon presence in streams throughout the CCC during the period 1989 to 2000. Scientists at NMFS' Southwest Fisheries Science Center have continued to compile information of coho salmon presence-absence and have incorporated data into a database that is now summarized by brood year (rather than year of sampling) and covers brood years 1986-2001. Data from CDFG's 2001 field survey of the Brown and Moyle (1991) streams has been incorporated into this database. Analyses presented in the present status review update supercede those presented in NMFS (2001b).

CDFG presence-absence analysis

Methods—Methods used by CDFG (2002) for analyzing presence-absence information in the CCC differed from those used for the SONCC analysis. Analysis focused on results from CDFG's 2001 summer juvenile sampling effort in which 135 of 173 streams identified by Brown

and Moyle (1991) as historical coho salmon streams within the CCC ESU were sampled. Additionally, CDFG assumed presence of coho salmon in any stream for which presence had been detected during any 3 consecutive years during the period 1995-2001. An estimate of percent coho salmon presence was calculated by totaling the number of streams for which presence was either observed or assumed, and dividing by the total number of streams surveyed, inclusive of those where presence was assumed. No formal statistical analysis of trends was performed because of the lack of comparable data from previous time periods.

Results—For the CCC ESU as a whole, CDFG (2002) estimated that coho salmon were present in 42% of streams historically known to contain coho salmon. Estimated occupancy was highest in Mendocino County (62%), followed by Marin County (40%), Sonoma County (4%), and San Francisco Bay tributaries (0%) (Table C.2.3.2). Although the numbers are not directly comparable with those derived by Brown et al. (1994), because the specific streams and methods used differ between the two studies, the general regional and overall ESU patterns are similar (Table C.2.3.2). The apparent decrease in percent presence in Marin County is likely a function of the increase in number of streams surveyed by CDFG rather than actual extirpations of populations.

NMFS presence-absence analysis

Methods—Scientists at NMFS' Southwest Fisheries Science Center compiled survey information from streams with historical or recent evidence of coho salmon presence within the CCC ESU. Data were provided primarily by the California Department of Fish and Game, private landowners, consultants, academic researchers, and others who have conducted sampling within the CCC during the years 1988 to 2002. The majority of data come from summer juvenile surveys, though information from downstream migrant trapping and adult spawner surveys were also included. Observations of presence or absence for a particular stream were assigned to the appropriate brood year based on the life stages observed (or expected in the case of absences). The resulting dataset spans brood years 1987 to 2001, though data from the 2002 summer field season (brood year 2001) were not fully reported at the time the analysis was performed.

Results for NMFS' presence-absence analysis are presented by major watersheds or aggregations of adjacent watersheds. Results from larger watersheds are typically presented independently, whereas data from smaller coastal streams, where data were relatively sparse, are grouped together. In a few cases, individual smaller coastal streams with only a few observations were aggregated with adjacent larger streams if there was no logical geographic grouping of smaller streams.

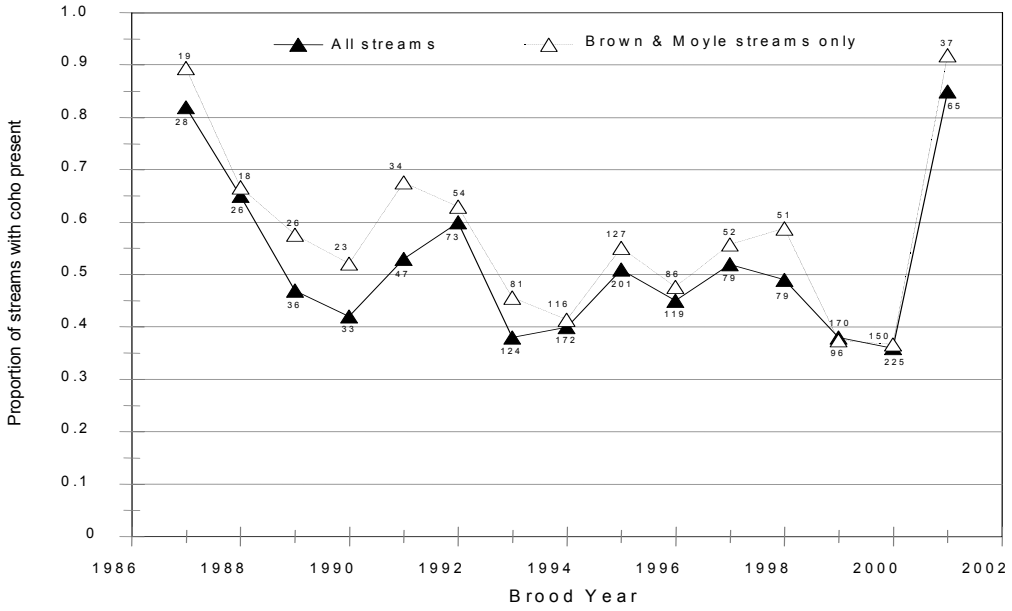

Figure C.2.3.1. Percent of streams surveyed for which coho salmon presence was detected, by brood year, for all historic coho streams (solid triangles) and coho streams identified in Brown and Moyle's (1991) historical list (open triangles) within the CCC ESU. Sample sizes (i.e. number of streams surveyed) are shown above next to data points. Data are from combined NMFS and CDFG datasets.

Results—The estimated percentage of streams in which coho salmon were detected shows a general downward trend from 1987 to 2000, followed by a substantial increase in 2001 (Figure C.2.3.1). Several caveats, however, warrant discussion. First, the number of streams surveyed per year also shows a general increase from 1987 to 2000; thus, there may be a confounding influence of sampling size if sites surveyed in the first half of the time period are skewed disproportionately toward observations in streams where presence was more likely. Second, sample size from brood year 2001 was relatively small and the data were weighted heavily toward certain geographic areas (Mendocino County and systems south of the Russian River). The data for brood year 2001 included almost no observations from watersheds from the Navarro River to the Russian River, or tributaries to San Francisco Bay, areas where coho salmon have been scarce or absent in recent years. Thus, while 2001 appears to have been a relatively strong year for coho salmon in the CCC as a whole, the high percentage of streams where presence was detected shown in Figure C.2.3.1 is likely inflated.

Two other patterns were noteworthy. First, compared with percent presence values for the SONCC ESU, values in the CCC were more highly variable and showed a somewhat more cyclical pattern. In general, percent occupancy was relatively low in brood years 1990, 1993, 1996, and 1999, suggesting that this brood lineage is in the poorest condition. In contrast, during the 1990s, percent occupancy tended to be high in brood years 1992, 1995, 1998, and 2001, suggesting that this is the strongest brood lineage of the three. Second, there is a general tendency for percent occupancy to be slightly higher (2%-15%) for the Brown and Moyle streams compared with the ESU as a whole, indicating that the Brown and Moyle streams do not constitute a random subset of CCC streams.

When data are aggregated over brood cycles (3-year periods), the percentage of streams with coho salmon detected shows a similar downward trend, from 73% in 1987-1989, to 63% in 1990-1992, to less than 50% in the last three brood cycles (Table C.2.3.3). Again there are confounding influences of increased sampling fraction through time and incomplete reporting for the 2001 brood year. Nevertheless, it appears that the percent of historical streams occupied continued to decline from the late 1980s to the mid-1990s and remains below 50% for the ESU as a whole. Additionally, coho salmon appear to be extinct or nearing extinction in several geographic areas including the Garcia River, the Gualala River, the Russian River, and San Francisco Bay tributaries. There is also evidence that some populations that still persist in the southern portion of the range, including Waddell and Gazos creeks, have lost one or more brood lineages (Smith 2001).

Results from our presence-absence analysis are generally concordant with CDFG's analysis. The two studies show consistent regional patterns suggesting that within the CCC the proportion of streams occupied is highest in Mendocino County, but that populations in streams in the southern portion of the range (excluding portions of Marin County) have suffered substantial reductions in range. NMFS analysis is more suggestive of a continued decline in percent occupancy from the late 1980s to the present; however, increased sampling in recent years may be confounding any trends.

Adult time series

No time series of adult abundance free of hatchery influence and spanning 8 or more years are available for the CCC ESU. Adult counts from the Noyo Egg Collecting Station (ECS) dating back to 1962 represent a mixture of naturally produced and hatchery fish, and counts are incomplete most years since trap operation typically ceased after brood stock needs were met. Thus, at best they represent an index of abundance. Assuming that these counts reflect general population trends, there appears to have been a significant decline in abundance of coho salmon in the South Fork Noyo River beginning in 1977 (Figure C.2.3.2). No formal analysis of trends was conducted because of the uncertainty of the relationship between catch statistics and population size, as well as the relative contribution of hatchery fish to total numbers during the entire period of record.

Smolt time series

California Department of Fish and Game personnel have trapped outmigrating smolts at Caspar Creek and Little River since 1986. These counts are partial counts, uncorrected for capture efficiency. As such, they provide only indices of abundance. However, they likely capture gross changes in smolt abundance over the years (Figure C.2.3.3). The most recent 5-year means were 1,168 and 379 for Caspar Creek and Little River, respectively. For both locations, the estimated long-term trend is negative (but not significantly different from 0), while the short-term trend is positive (also not significantly different from 0) (Table C.2.3.4). For Little River, smolt counts were higher in each year from 1986 to 1989 than in any year since. For both sites, lambda values are greater than 1, though 95% confidence limits indicate the values are not significantly different from one.

Table C.2.3.3. Percent of surveyed streams within the CCC ESU for which coho salmon were detected for four time intervals: brood years 1987-1989, 1990-1992, 1993-1995, 1996-1998, and 1999-2001. Streams include those for which historical or recent evidence of coho salmon presence exists (based on combined NMFS and CDFG data).

		1987-1989			1990-1992			1993-1995			1996-1998			1999-2001		
County and River Basins	**Number of Streams with Historical Presence**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**	**Number Surveyed[1]**	**Coho Present[2]**	**Coho Absent[3]**
Mendocino																
Coastal (Punta Gorda to Abolabodiah Cr.)	24	4	75%	25%	6	50%	50%	16	50%	50%	11	18%	82%	19	32%	68%
Ten Mile River	25	6	50%	50%	15	53%	47%	17	65%	35%	14	57%	43%	16	94%	6%
Pudding Cr. to Noyo River	43	4	75%	25%	8	88%	13%	35	66%	34%	15	80%	20%	38	68%	32%
Coastal (Hare Cr. to Russian Gulch)	14	8	100%	0%	4	100%	0%	9	67%	33%	9	67%	33%	4	75%	25%
Big and Little Rivers	28	5	20%	80%	7	57%	43%	20	75%	25%	16	81%	19%	16	38%	63%
Albion River	16	3	100%	0%	3	100%	0%	15	80%	20%	1	100%	0%	14	86%	14%
Little Salmon & Big Salmon Cr.	6	0	0%	100%	3	100%	0%	4	75%	25%	4	75%	25%	4	100%	0%
Navarro River	30	1	100%	0%	1	0%	100%	24	58%	42%	6	67%	33%	23	52%	48%
Coastal (Greenwood Cr. to Brush Cr.)	8	3	0%	100%	2	50%	50%	8	13%	88%	0	0%	100%	8	0%	100%
Garcia River to Digger Cr.	8	3	100%	0%	2	0%	100%	8	13%	88%	5	20%	80%	7	0%	100%
Sonoma																
Gualala River	15	1	100%	0%	1	0%	100%	11	0%	100%	1	0%	100%	11	9%	91%
Fort Ross to Russian River	53	4	50%	50%	14	50%	50%	37	51%	49%	29	24%	76%	36	8%	92%
Marin																
Tomales Bay Rivers	25	3	100%	0%	4	100%	0%	14	36%	64%	10	90%	10%	21	57%	43%
Coastal (Redwood Cr. to Bolinas Lagoon)	6	0	0%	100%	1	100%	0%	2	50%	50%	4	75%	25%	5	100%	0%
San Francisco Bay																
SF Bay Rivers	6	0	0%	100%	4	0%	100%	6	0%	100%	4	0%	100%	0	0%	100%
San Mateo/Santa Cruz																
Coastal (SF Bay to Aptos Creek)	17	7	100%	0%	7	100%	0%	13	69%	31%	14	57%	43%	12	67%	33%
Monterey																
Coastal (Carmel R. to Big Sur R.)	2	0	0%	100%	0	0%	100%	2	0%	100%	0	0%	100%	2	0%	100%
ESU Total	**326**	**52**	**73%**	**27%**	**82**	**63%**	**37%**	**241**	**53%**	**47%**	**143**	**54%**	**46%**	**236**	**48%**	**52%**

[1] Total number of steams surveyed at least once within the three-year interval

[2] Percentage of surveyed streams where coho were present in one or more years during the interval

[3] Percentage of surveyed streams where coho were absent in all years of survey during the interval

Table C.2.3.4. Population trend analysis for Caspar Creek and Little River smolt outmigrant data. Trends are based on smolt counts uncorrected for trap efficiency (see text). Data source: Scott Harris, CDFG, unpublished data.

Stream	5-year mean	5-year min.	5-year max.	Lambda	Long-term trend [a]	Short-term trend [a]
Caspar Cr.	1,168	830	1,383	1.002 (0.851, 1.178)	-0.017 (-0.081, 0.048)	0.040 (-0.069, 0.149)
Little R.	379	82	1,203	0.919 (0.669, 1.347)	-0.063 (-0.358, 0.232)	0.273 (-0.256, 0.803)

[a]Values in parentheses are lower and upper bounds for 95% confidence limits.

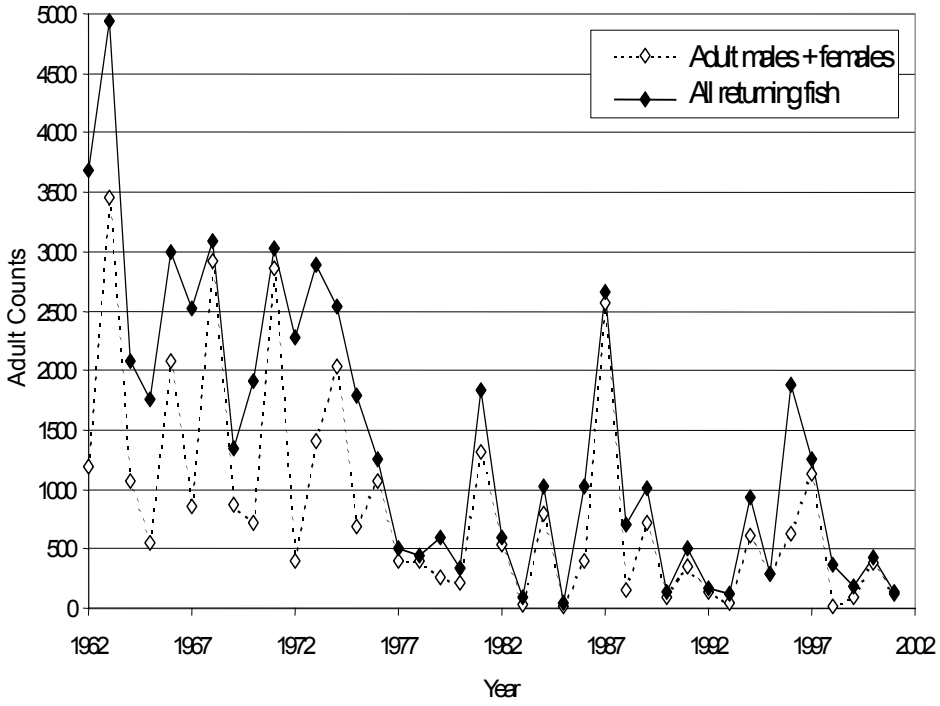

Figure C.2.3.2. Counts of adult coho salmon at Noyo Egg Collecting Station from 1962 to 2002. Solid line with closed symbol indicates total fish captured (including grilse); dashed line with open symbols indicates adult males and females only. Counts are partial counts and thus are only a crude index of adult abundance. Data source: Grass 2002.

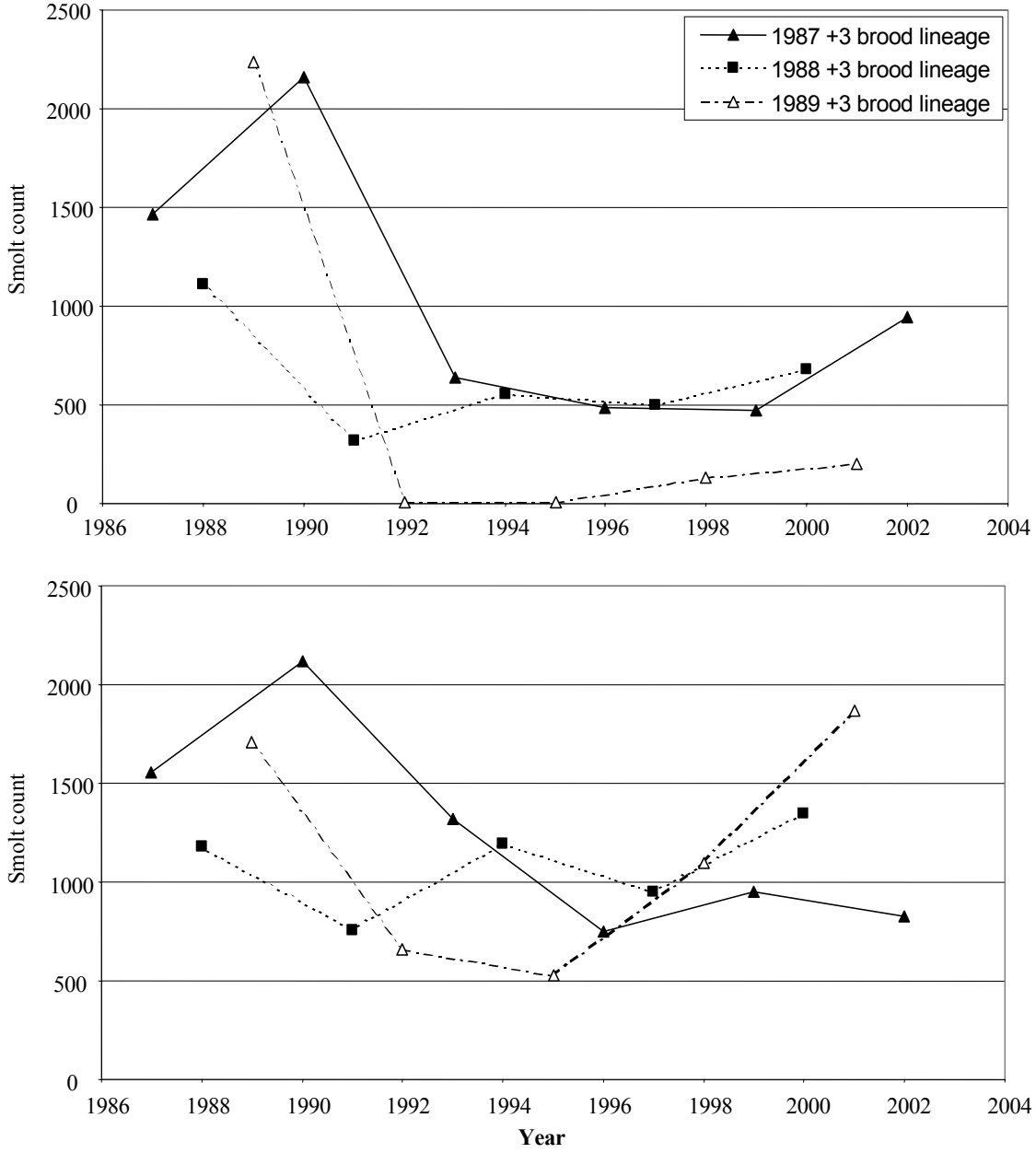

Figure C.2.3.3. Coho salmon smolt counts at a) Caspar Creek and b) Little River, Mendocino County. Lines track brood lineages. Data are counts of smolts uncorrected for trap efficiency and thus should be viewed as coarse indices of abundance.

Table C.2.3.5. Trend slopes and confidence intervals for nine putative coho populations in the CCC ESU.

Watershed	No. Sites	Aggregate Slope	95% confidence interval	
			Lower bound	Upper bound
Pudding Creek	1	-0.019	-0.103	0.065
Noyo River	8	-0.091	-0.195	0.013
Caspar Creek	2	-0.039	-0.109	0.030
Little River	2	-0.044	-0.118	0.029
Big River	2	0.146	-0.001	0.293
Big Salmon Creek	5	-0.005	-0.110	0.100
Lagunitas Creek	3	0.095	-0.123	0.312
Redwood Creek	1	0.091	-0.345	0.527
Waddell/Scott/Gazos creeks	3	-0.111	-0.239	0.018

Juvenile time series

Methods—While recent estimates of adult and smolt abundance are scarce for the CCC ESU, estimates (or indices) of juvenile density during summer have been made at more than 50 index sites within the CCC in the past 8 to 18 years. Methods for analyzing these data are described in detail in the SONCC coho salmon status review update. Briefly, data from individual sampling sites were ln-transformed and normalized to prevent spurious trends arising from different data collection methods or reporting units. Data were then grouped into units thought to represent plausible independent populations, based on watershed structure. Trends were then estimated for putative populations by estimating the slope (and associated 95% confidence intervals) for the aggregated data. Analysis was restricted to 1) sites where a minimum of 6 years of data were available, and 2) putative populations where more than 65% of all observations were non-zero values.

Nine geographic areas (putative populations) were represented in the aggregated data including Pudding Creek, Noyo River, Caspar Creek, Big River, Little River, Big Salmon Creek, Lagunitas Creek, Redwood Creek, and coastal streams south of San Francisco Bay, including Waddell, Scott, and Gazos creeks. Spatially, these sites cover much of the CCC ESU; however, several key watersheds are not represented, including the Ten Mile, Navarro, Garcia, Gualala, and Russian Rivers. Although considerable sampling has been done in the Ten Mile River basin, the high proportion of zero values precluded analysis of these data.

Results—Overall, analysis of juvenile data provided little evidence of either positive or negative trends for the putative populations examined. Estimated slopes were negative for six populations and positive for three; however, none of the estimated slopes differed significantly from zero (Table C.2.3.5).

C.2.3.3 New Comments

Homer T. McCrary, vice president of Big Creek Lumber, submitted 375 pages comprised primarily of excerpts from historical documents related to operation of hatcheries in Santa Cruz County from the early 1900s to 1990. The expressed intent of this compilation was "to assist the efforts of resource professionals, scientists, regulators, fisheries restoration advocates and all interested parties in establishing a more complete historical perspective on salmonid populations." Quantitative information regarding hatchery and stocking histories is discussed in the Harvest Impact section.

C.2.3.4 New Hatchery/ESU Information

The BRT (Weitkamp et al. 1995) identified four production facilities that had recently produced coho salmon for release in the CCC ESU: the Noyo Egg Collecting Station (reared at Mad River Hatchery) and Don Clausen (Warm Springs) hatchery, both operated by CDFG; Big Creek Hatchery (Kingisher Flat Hatchery), operated by the Monterey Bay Salmon and Trout Program; and the Silver-King ocean ranching operation. The latter facility closed in the late 1980s.

Noyo Egg Collecting Station—The Noyo Egg Collecting Station, located on the South Fork Noyo River approximately 17 km inland of Fort Bragg, began operating in 1961 and has collected coho salmon in all but a few years since that time. Fish have historically been reared at the Mad River Hatchery, Don Clausen (Warm Springs) Hatchery, and the Silverado Fish Transfer Station. There are no records of broodstock from other locations being propagated with Noyo fish for release back into the Noyo system, but a few out-of-ESU transfers directly into the Noyo system have been recorded, including Alsea and Klaskanine, OR stocks (SSHAG 2003).

Average annual release of coho salmon yearlings was 108,000 from 1987-1991 (Weitkamp et al. 1995), declined to about 52,000 between 1992 and 1996, and then increased again to about 72,000 fish between 1997 and 2002, inclusive of 2 years where no yearlings were released (Table C.2.3.6). Releases have been made exclusively to the ECS or elsewhere in the South Fork Noyo drainage in the past decade. Between 1991 and 2001, adult returns averaged 572 individuals, though these represent incomplete counts in most years, as counting typically ceased after broodstock needs were met (Grass 2002). On average, 91 females were spawned annually during this 11-year period (Grass 1992-2002).

There are no basin-wide estimates of natural and artificial production for the Noyo Basin as a whole; however, marking of coho salmon juveniles released from the Noyo ECS on the South Fork began in 1997, and returns have been monitored since the 1998-1999 spawning season. In the 1998, 1999, and 2000 brood years, marked hatchery fish constituted 85%, 70%, and 80%, respectively, of returning adults captured at the ECS.

The BRT (Schiewe 1996a) concluded that, although exotic stocks have occasionally been introduced into the Noyo system, the regular incorporation of local natural fish into the hatchery population made the likelihood that this population differs substantially from naturally spawning fish in the ESU is low and, therefore, included them in the ESU. Since CCC coho salmon were

listed, no significant changes in hatchery practices have occurred. The Noyo ECS operation has been classified as a Category 1 hatchery (SSHAG 2003).

Don Clausen (Warm Springs) Hatchery—The Don Clausen Hatchery (a.k.a. Warm Springs stock), located on Dry Creek in the Russian River system 72 km upstream of the mouth, began operating in 1980. Initial broodstock used were from the Noyo River system, and Noyo fish were planted heavily from 1981 to 1996.

Average annual releases of coho salmon from the hatchery decreased from just over 123,000 in the 1987-1991 period to about 57,000 in the years between 1992 and 1996, and Noyo River broodstock continued to constitute about 30% of the releases during the latter period. Production of coho salmon at the facility ceased entirely after 1996 (Table C.2.3.6). Adult returns averaged 245 fish between 1991 and 1996, but following the cessation of releases, no more than four coho salmon have been trapped at the hatchery in any subsequent year.

Because the Warm Spring population was originally derived from Noyo River stock and continued to receive transfers from the Noyo system throughout its operation, the BRT concluded that the hatchery population was not a part of the ESU.

Beginning in 2001, however, a captive broodstock program was initiated at the Don Clausen facility. A total of 337 juveniles were electro-fished from Green Valley and Mark West Springs creeks, two Russian River tributaries that still appear to support coho salmon, as well as Olema Creek, a tributary to Lagunitas Creek. Specific mating protocols for these fish have not yet been determined. The captive broodstock program proposes to eventually release 50,000 fingerlings and 50,000 yearlings into five Russian River tributaries. Under the captive broodstock program, the Don Clausen Hatchery has been classified as a Category 1 hatchery (SSHAG 2003).

Kingfisher Flat (Big Creek) Hatchery—The Monterey Bay Salmon and Trout Program (MBSTP) has operated Kingfisher Flat Hatchery, located on Big Creek, a tributary to Scott Creek, since 1976. The facility is near the site of the former Big Creek Hatchery, which was operated from 1927 to 1942, when a flood destroyed the facility. An additional facility in Santa Cruz County, the Brookdale Hatchery on the San Lorenzo River, operated from 1905 to 1953. Both the Big Creek and Brookdale hatcheries were supplied with eggs taken at an egg-collection facility located on Scott Creek; additional eggs were provided from other hatcheries around the state. Production of coho salmon at both hatcheries was sporadic. Releases of Sisson (Mt. Shasta) coho salmon were made in Scott Creek and other Santa Cruz County streams in 1913, 1915, and 1917. In subsequent years, releases from both facilities back into Scott Creek in included both Scott Creek fish (1929, 1930, 1934, and 1936-1939), as well as fish from Ft. Seward, Mendocino County (1932), and Prairie Creek, Humboldt County (1933, 1935, and 1939). Throughout these years, only fry were released (generally during July through September), and numbers of fish were relatively small. In the 10 years between 1929 and 1939, during which coho salmon were planted in Scott Creek, the total fry release averaged about 34,000 fish. During the Silver-King operation, broodstock was obtained from Oregon, Washington, British Columbia, and Alaska.

Table C.2.3.6. Average annual releases of coho salmon juveniles (fry and smolts) from hatcheries in the CCC coho salmon ESU during release years 1987-1991, 1992-1996, and 1997-2002. Data

sources: Weitkamp et al. 1995; Grass 1992-2002; Williams 1993; Cartwright 1994; Quinones 1995-1999; CDFG Hatchery Staff 2000; Wilson 2001-2002.

Hatchery	SSHAG Cat.	Annual Average Releases 1987-1991	1992-1996	1997-2002
Monterey Bay Salmon and Trout	1	25,764	na[a]	na[a]
Silver-King		95,074[b]	0[c]	0[c]
Noyo Egg Collecting Station	1	107,918	52,012[d]	72,363[e]
Don Clausen (Warm Springs) Hatchery	1	123,157	56,891[f]	0[g]
Total		351,913	108,903	72,363

[a] Data not available; however, operations have been sporadic over last 10 year due to low adult returns.
[b] Average from 4 years of data (1984-1988).
[c] Ceased operating in the 1980s.
[d] No yearling coho were released in 1995.
[e] No yearling coho were released in 2000 or 2001.
[f] Releases included both Warm Springs Hatchery and Noyo River ECS fish.
[g] Don Clausen Hatchery ceased releasing coho salmon in 1996.

Since 1976, when MBSTP began operating the Kingfisher Flat Hatchery, only local brood stock have been used at the hatchery. Mating protocols follow a priority scheme in which wild x wild broodstock are used in years of relatively high abundance, wild x hatchery crosses are done when wild fish are less available, and hatchery x hatchery crosses are made when wild fish are unavailable (D. Streig, MBSTP, pers. commun.). Under the current management plan, up to 30 females and 45 males can be taken with the restriction that the first 10 spawning pairs observed must be allowed to spawn undisturbed in their natural habitat, and then only one in four females may be taken to spawn. In recent years, few or no fish have been taken, due to low abundance; however, in 2001, 123 coho were observed and 26 "wild" females were taken for spawning. Of the 123 coho observed, 40% were marked hatchery fish. There are no other data available to assess the relative contribution of hatchery versus naturally produced coho salmon.

In its 1996 coho status review update, the BRT concluded that the Kingfisher Flat (Scott Creek) hatchery population should be considered part of the ESU and was essential for ESU recovery (Schiewe 1996a). This was based on the fact that there was regular incorporation of local broodstock into the hatchery population in the years that coho were produced between 1905 and 1943, and there have been no out-of-basin or out-of-ESU transfers since the hatchery was restarted in 1976. The MBSTP operation has been classified as a Category 1 hatchery (SSHAG 2003). For other SSHAG categorizations of hatchery stocks, see Appendix C.5.1.

A captive broodstock program for Scott Creek will be initiated at the NMFS Santa Cruz Laboratory in 2003.

Summary

Artificial propagation of coho salmon within the CCC ESU has been reduced since this ESU was listed in 1996 (Table C.2.3.6). The Don Clausen Hatchery has ceased production of coho salmon, and releases from the Noyo ECS operation declined over the past 6 years, in part because coho were not produced during 2 of those 6 years. The Monterey Bay Salmon and Trout Program has produced few coho salmon for release in the last 6 years due to low adult returns to

Scott Creek. Genetic risks associated with out-of-basin transfers appear minimal. However, potential genetic modification in hatchery stocks resulting from domestication selection or low effective population size remains a concern.

Harvest impacts

Retention of coho salmon by commercial troll fishers south of Cape Falcon, Oregon, has been prohibited since 1993 (PFMC 2002). From Cape Falcon, OR, south to Horse Mountain, CA, retention of coho salmon in recreational ocean fisheries has been prohibited since 1994, and in 1995 this prohibition was extended to include all California ocean recreational fisheries (CDFG 2002b). The conservation objective set by the Pacific Fishery Management Council for the past five seasons has been an overall ocean exploitation of $\leq$13% for CCC coho salmon as indicated by Rogue/Klamath hatchery stocks (PFMC 2002b). Post-season estimates of Rogue/Klamath exploitation rate are unavailable; however, projected exploitation rates ranged from 3.0% to 11.7% during the period 1998 to 2002 (PFMC 1998-2002a). Inside harvest estimates of coho salmon are not available for rivers in the CCC ESU (PFMC 2002b).

C.2.3.5 Comparison with Previous Data

New data for the CCC coho salmon ESU includes expansion of presence-absence analyses, an analysis of juvenile abundance in 13 river basins, smolt counts from two streams in the central portion of the ESU, and one adult time series for a population with mixed wild and hatchery fish. The presence-absence analysis suggests possible continued decline of coho salmon between the late 1980s and the late 1990s, a pattern that is mirrored in the limited smolt and adult counts. Juvenile time series suggest no obvious recent change in status, but most observations underlying that analysis were made in the period from 1993 to 2002. Coho salmon populations continued to be depressed relative to historical numbers, and there are strong indications that breeding groups have been lost from a significant percentage of streams within their historical range. A number of coho populations in the southern portion of the range appear either extinct or nearly so, including those in the Gualala, Garcia, and Russian Rivers, as well as smaller coastal streams in San Francisco Bay and South of San Francisco Bay. Although the 2001 brood year appears to relatively strong, data were not yet available from many of the most at-risk populations within the CCC.

No new information has been provided that suggests additional risks beyond those identified in previous status reviews. Termination of hatchery production at the Don Clausen (Warm Springs) Hatchery and reductions in production at the Noyo and Kingfisher Flat (Big Creek) facilities suggest a decrease in potential risks associated with hatcheries; however, the lack of substantive information regarding the relative contribution of hatchery and naturally produced fish at these facilities adds uncertainty as to the potential risks these operations may pose to the genetic integrity of the Noyo River and Scott Creek stocks. Restrictions on recreational and commercial harvest of coho salmon since 1994 have reduced exploitation rate on CCC coho salmon.